HINS PMG

April 5th, 2007

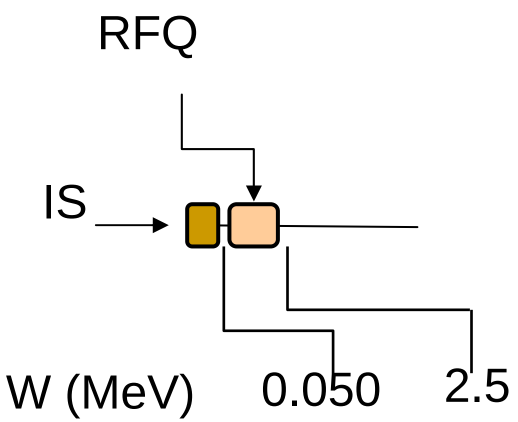
Agenda

HINS

- Beam-Line Elements -Technical Status and Issues (Giorgio)
- Plans for FY07-FY08 “
  - Funding of 2.2 M$ in FY07, 2.8 M$ in FY08
- Alignment of HINS with ILC multi-TeV system Test “

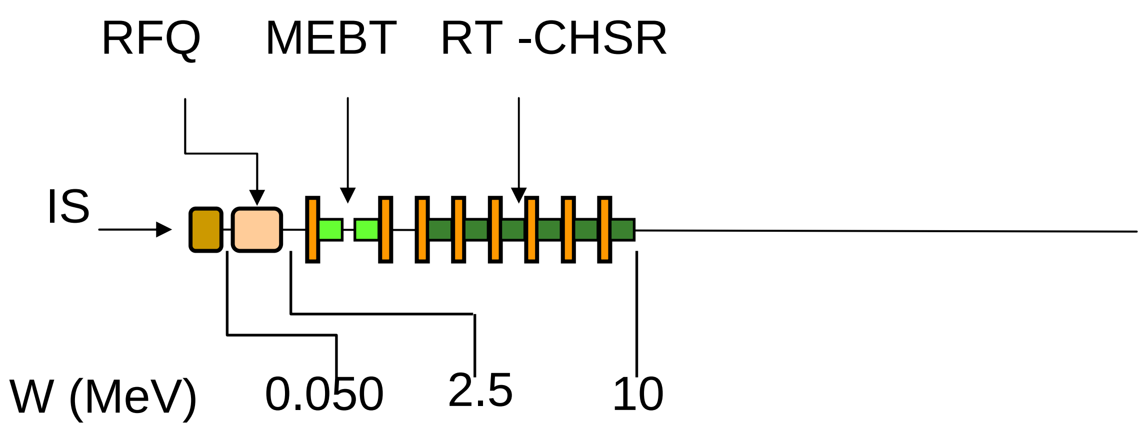
- Meson Facility - Technical Status and Issues (Bob)
- Compatibility of HINS and ILC Facilities in Meson “
- AD Involvement in HINS Operations “

HINS Front End - Stages (1) May AAC



+

- End FY06/Beg FY07
  - Klystron/Modulator/Power Distribution
  - RFQ
  - Test Cryostat/Prototype SSR
  - Klystron & Power Distribution

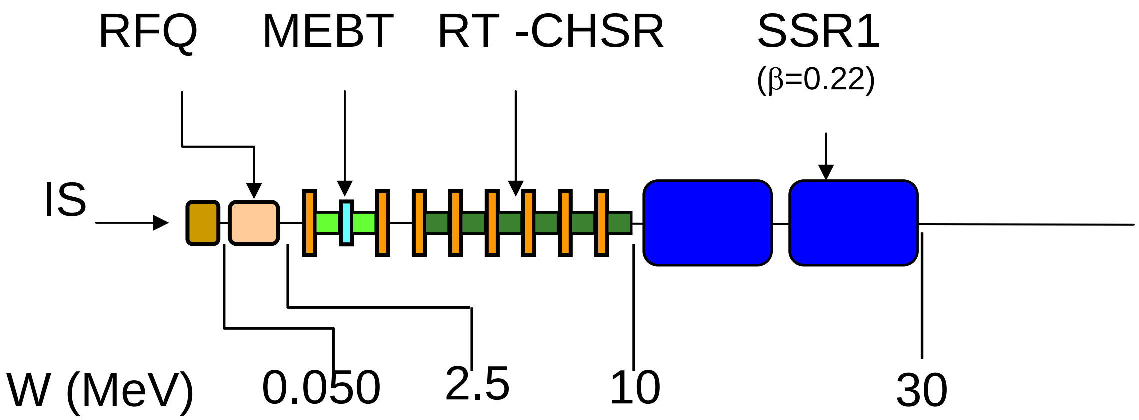


- End FY07/Beg FY08
  - RT Cavities
  - Focusing Solenoids
  - Buncher Cavities

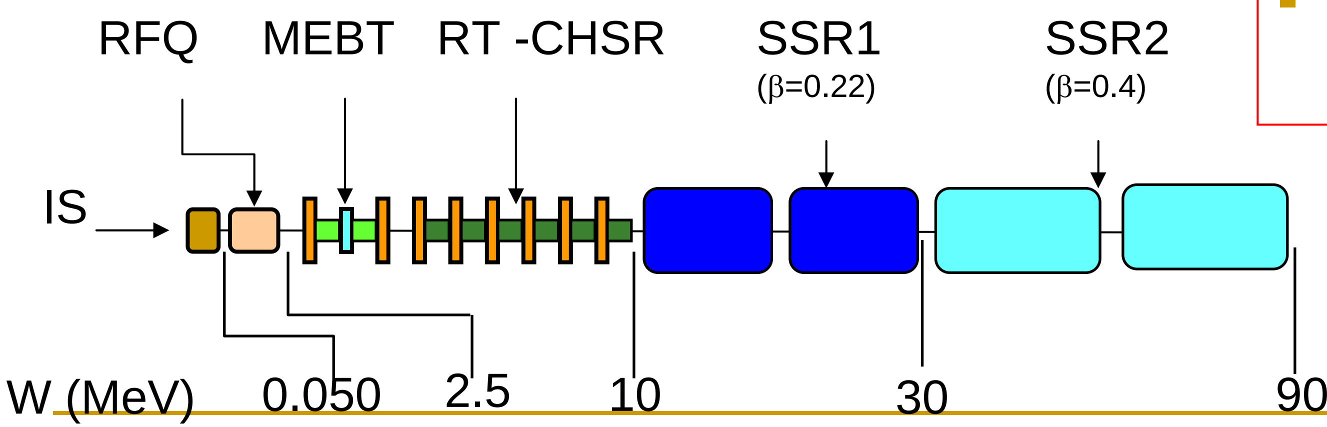
De-scoping Scenario: no Chopper

HINS Front End - Stages (2) May AAC

HINS



- End FY08/Beg FY09
  - 2 SSR1 cryostats
  - Chopper & PS
  - Linac Operation

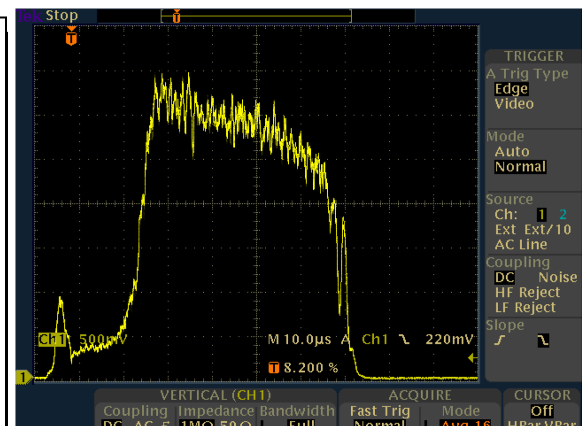


- End FY09/Beg FY10
  - 1 SSR2 cryostat
  - Linac Operation

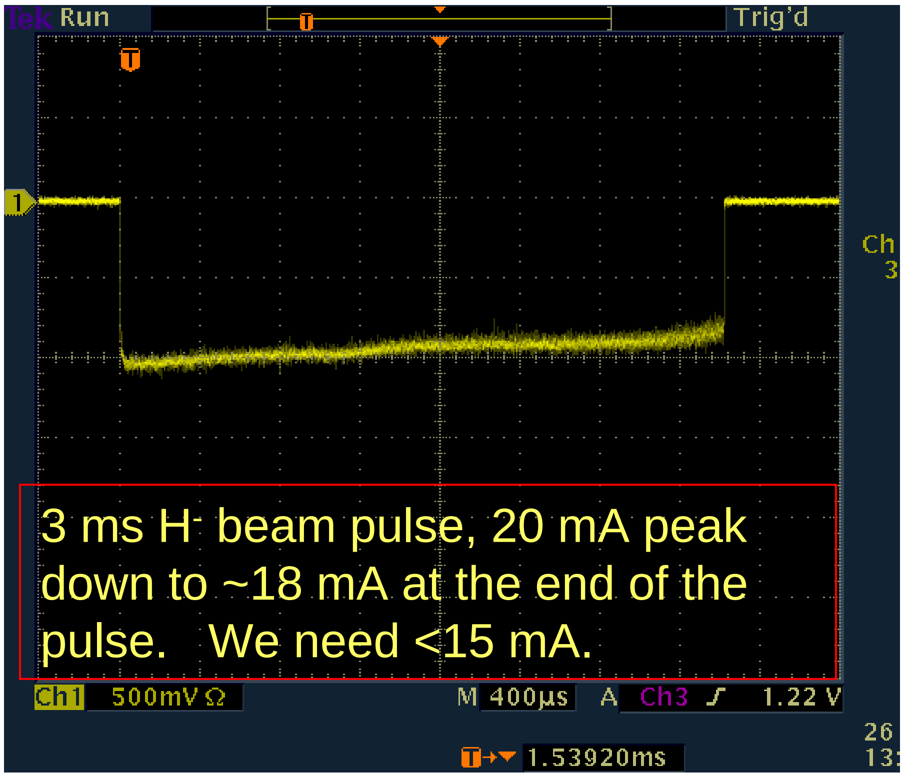
De-scoping Scenario:
1 SSR2 Cryomodule

Ion Source (H^+ Plasmatron in MS6)

- Proton beam 70 mA @ 45 KeV, but beam goes away above 47 KeV
- New modulator available now for 4 msec pulses, under testing



Ion Source (H^- Magnetron)



3 ms H^- beam pulse, 20 mA peak down to ~18 mA at the end of the pulse. We need <15 mA.

- Demonstrated:
  - 40 mA for 1 ms at 10 Hz (need 45mA for Phase 2)
  - 15 mA for 3 ms at 2 Hz (need 2.5 Hz for Phase 1)
- Problems with good quality emittance measurements!!!
  - Believe that emittance for the 20 mA beam meets HINS requirements.
- Finding reliable operating points is the key to success.
- Designs for mating the Magnetron H^- source to the LEBT should begin this month.
  - This will require engineering and drafting support

RFQ

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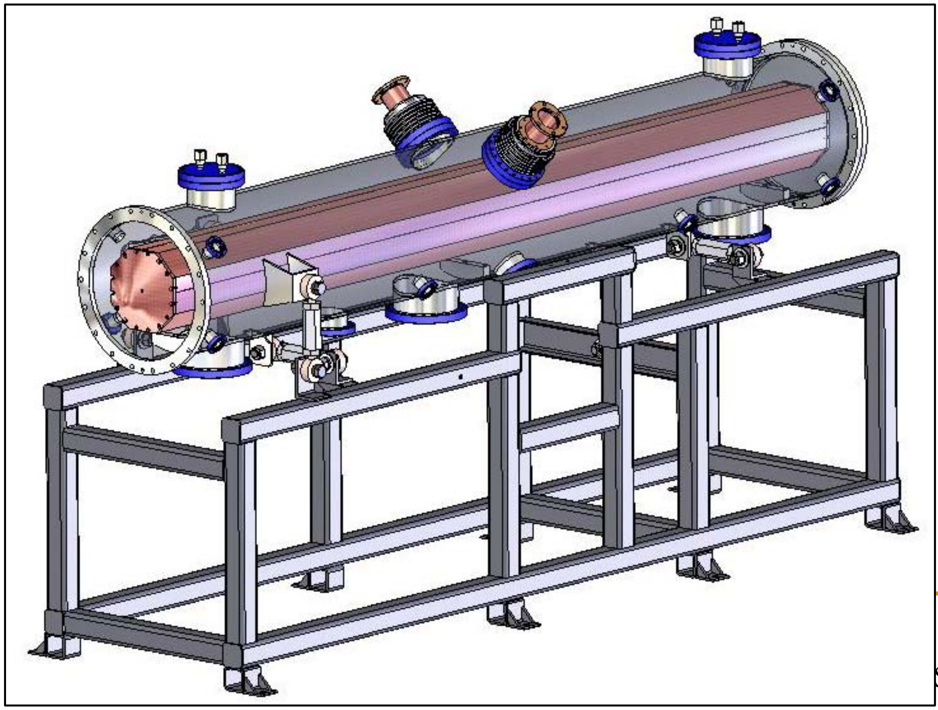
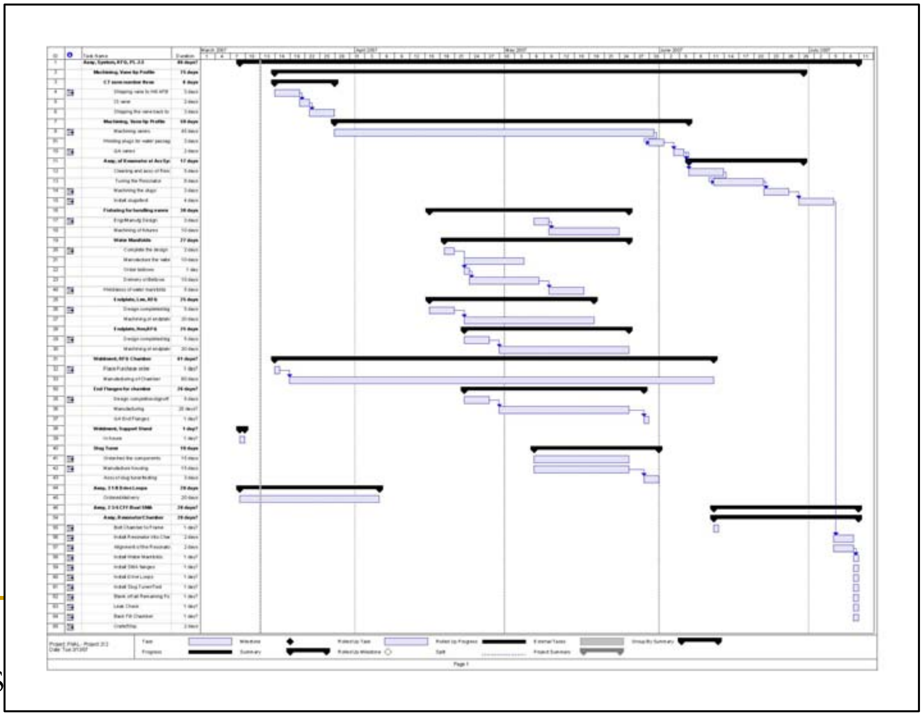
- Order placed with AccSys last year
  - Accsys acting has contractor
  - Vanes machined by subcontractor
- Slow-down by Nov' 06 due to "planned" subcontractor failing to bid.
- FNAL into picture, visit to AccSys & proposal of other subcontractors to AccSys.
- Vanes machined by end of April, RFQ @ FNAL by end summer.

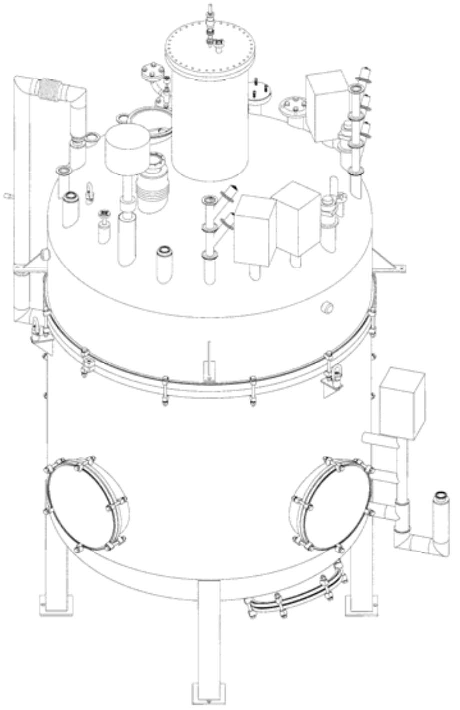




SCRF in FY07 – Test Cryostat

HINS

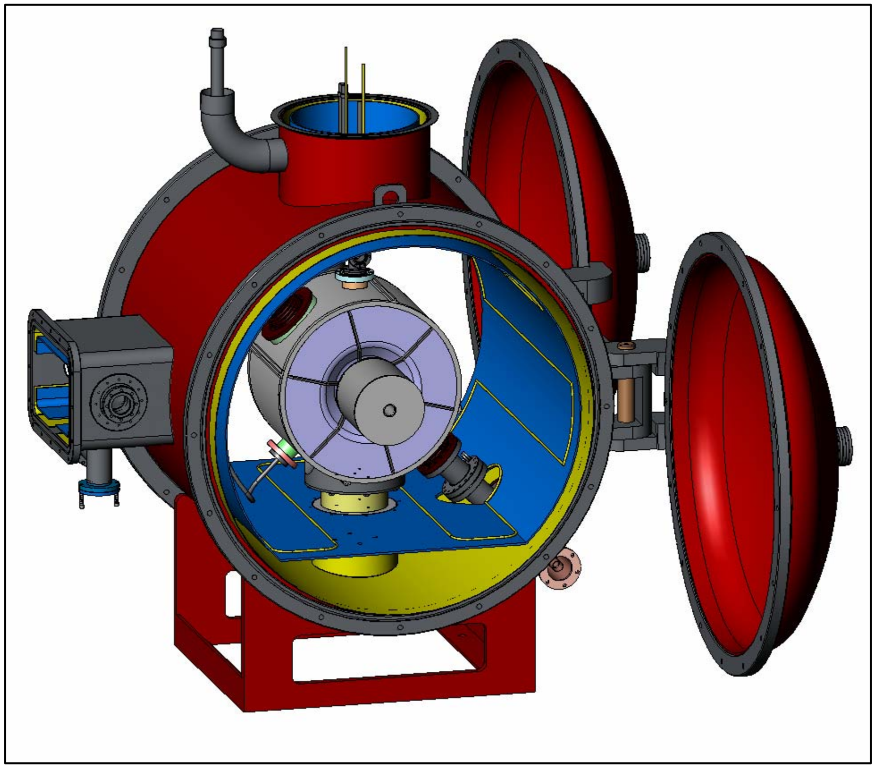
- Test Cryostat
  - Redesign in course due to high bid
  - 150 k$ in budget, lowest bid at 440k$

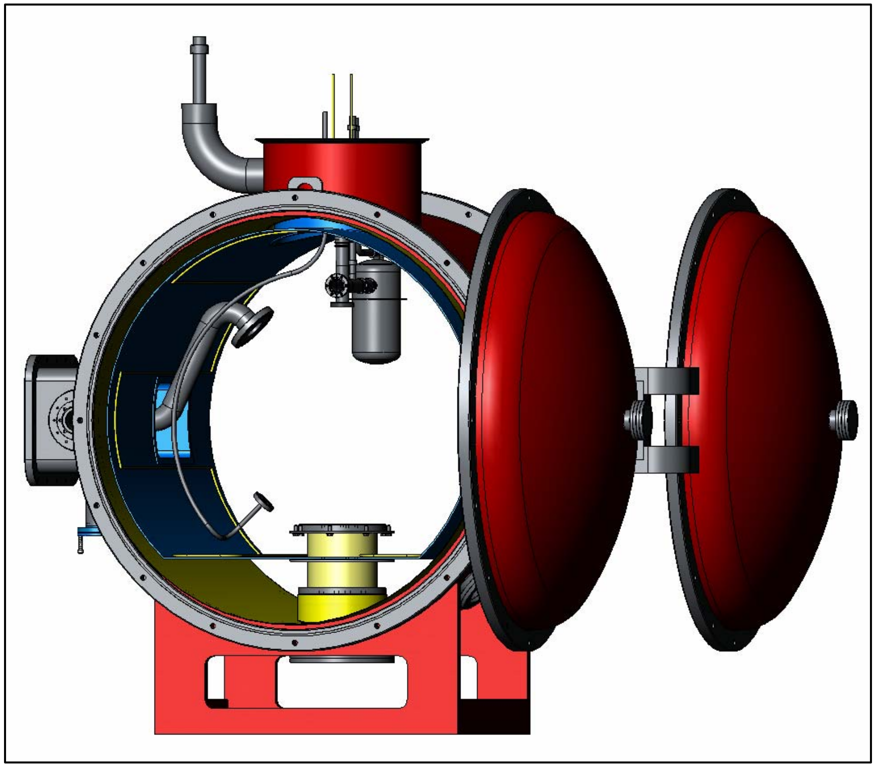


- Propose a horizontal test cryostat similar to the TTF capture cavity, ILC horizontal test cryostats and planned HINS horizontal cryostat, but without 2 K capability.
- Elimination of 2 K capability:
  - Reduces plumbing and valve count, eliminates large helium vessel inside cryostat, eliminates heat exchanger inside cryostat.
  - Precludes diagnostics afforded by 2 K capability.
- Horizontal orientation:
  - Eliminates need to remove shielding at each test article change.
  - Simplifies test article installation and removal.
  - Allows permanent cryogenic line installation, eliminating U-tube transfer lines.
- Implies another design, drafting, and bid cycle.

SCRF in FY07 – Test Cryostat

HINS





SCRF in FY07 – SSR1

RT Cavities

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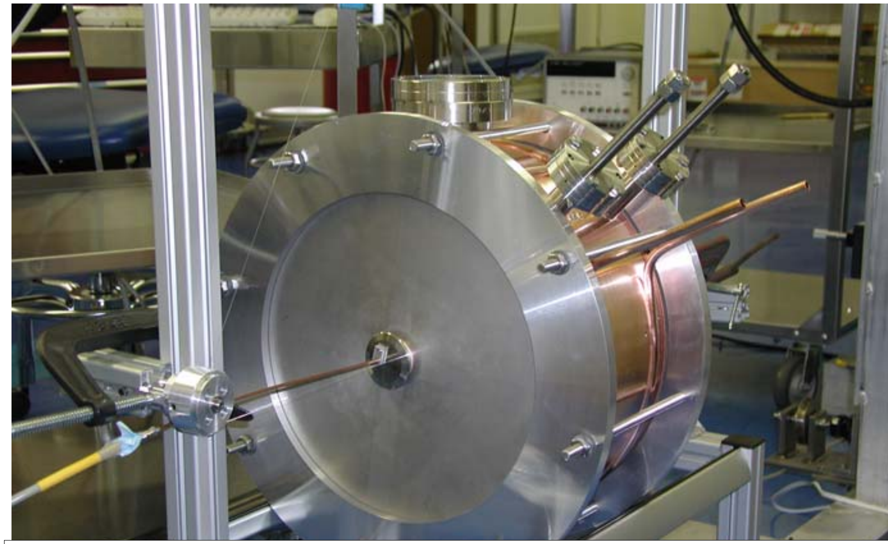
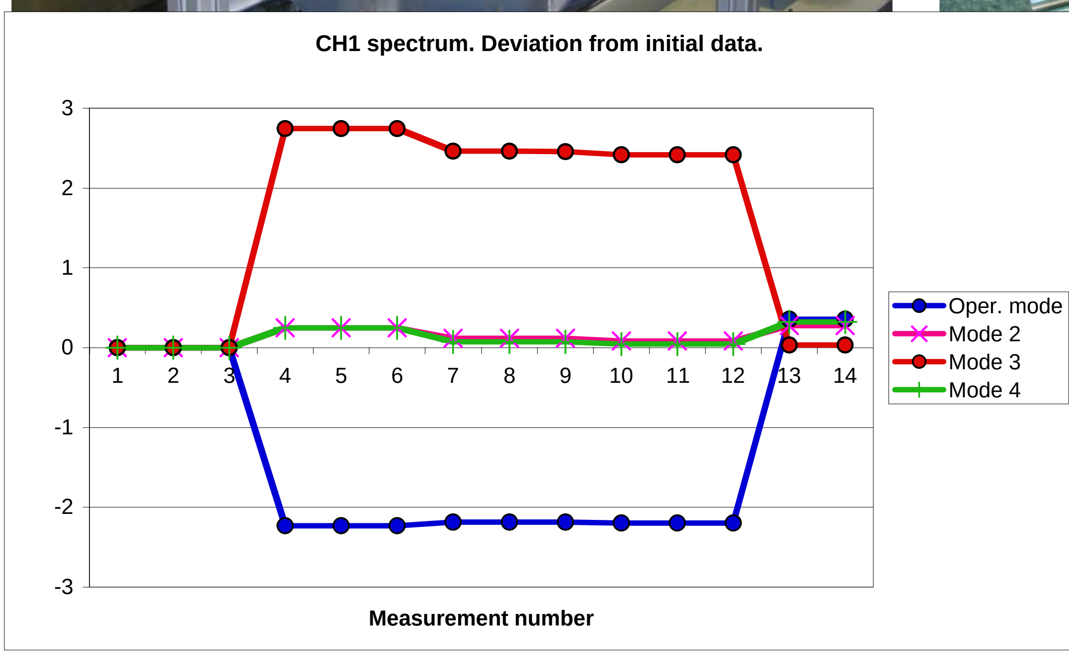
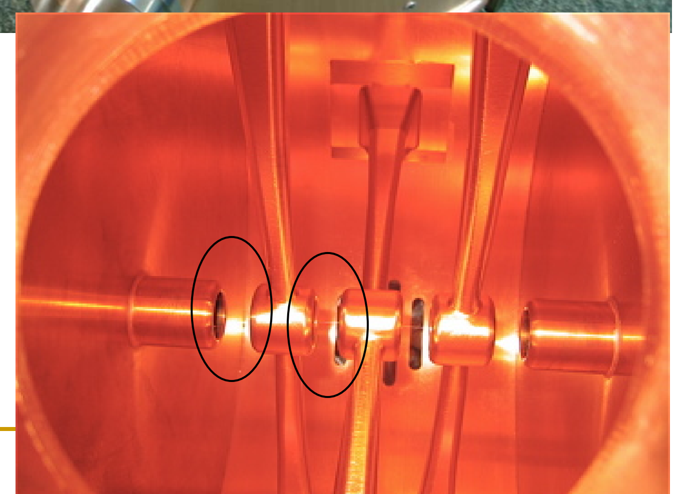
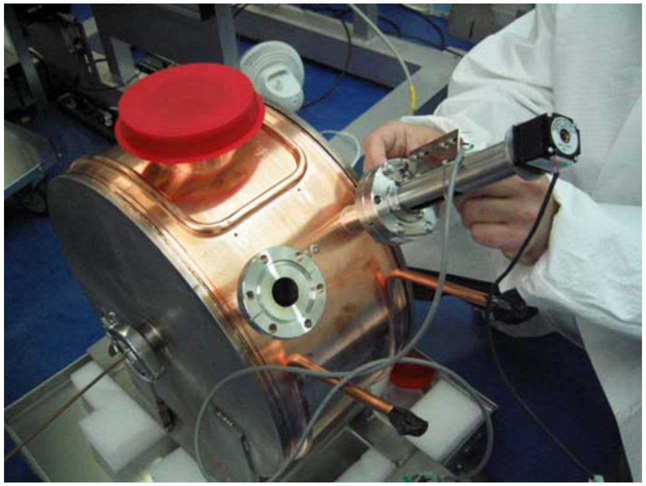
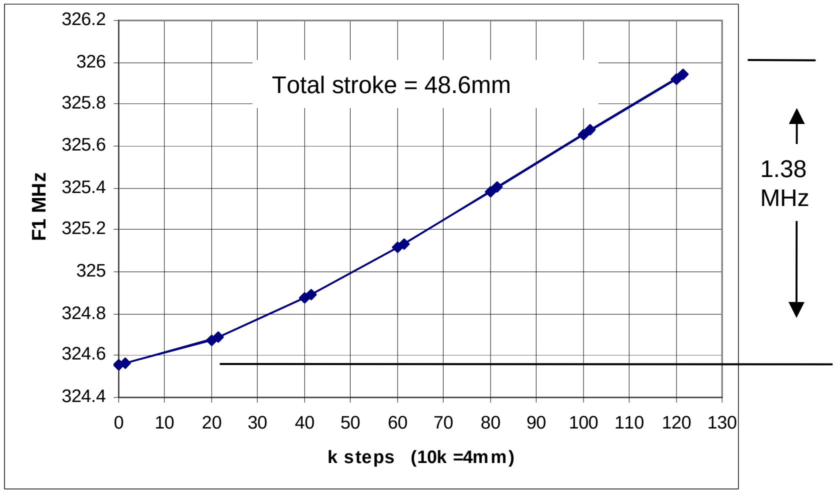


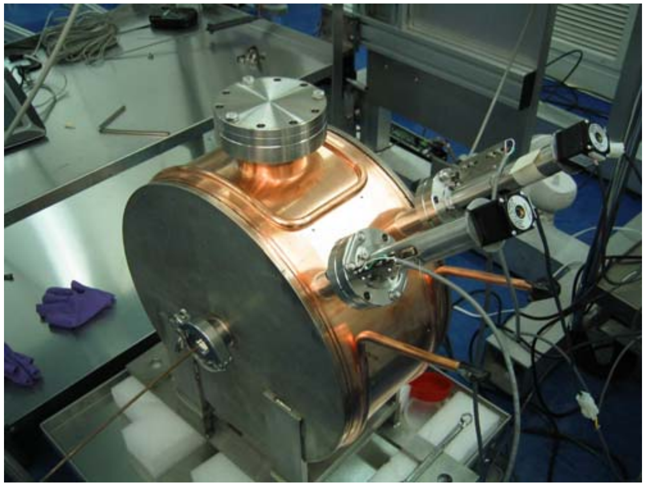




RT Cavities







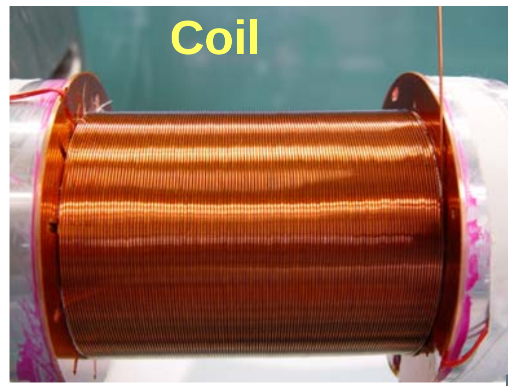
- Cavity OK
- Plungers OK
- Power Coupler Not OK
  - Bad brazing
  - Bad manufacturing
  - Vendor problem
- Order for cavities #2-#4 placed
- Will place order for #5-#16

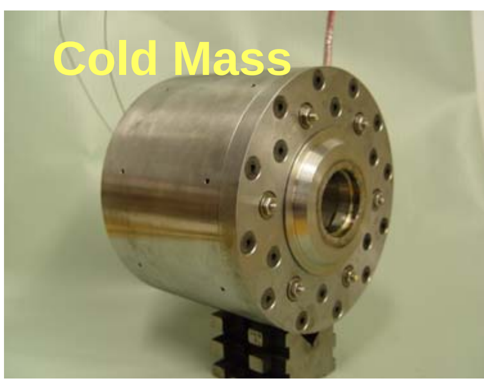
SC Solenoids in RT Section

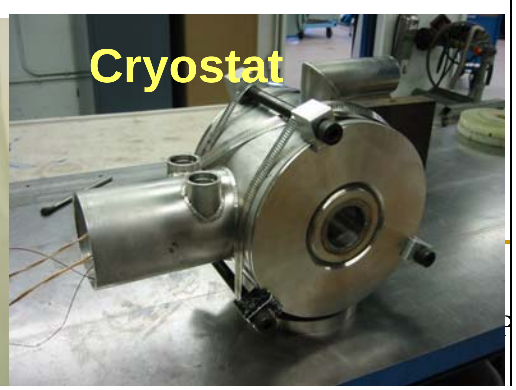
HINS

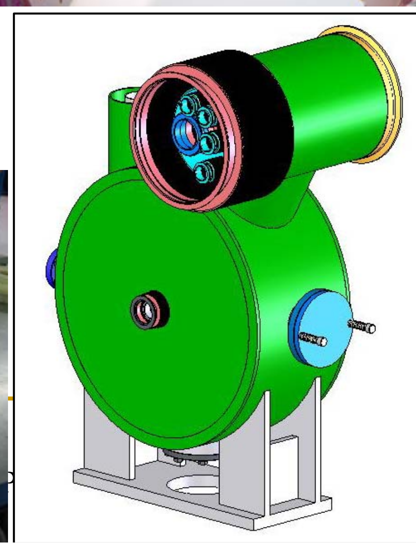
- R&D Completed for RT Section Solenoids
  - Simple Solenoids
  - Solenoids with Correction Coils
- "Scope of Work" document to vendor for RFP

Number of solenoids in the section	4(MEBT) + 19
Parameter	
Bore diameter (mm)	20
Bore type	warm
Integrated Strength ($T^2 \cdot mm$)	1800
Field margin	30%
Leff (cm) @ Bm	< 100 mm
1% field extension	< 2*Leff
Available insertion gap (cm)	235 mm









Funding in FY07 - Requests

Plans for FY07 M&S (no Overhead)

- Optimum Scenario
  - 5.3 M$ M&S
  - 3.6 M$ would be OK
    - 550 k$ for SSR1 in India
    - 800 k$ for 23 RT Sol.
    - 850 k$ for 23 RT Cav.
    - 550 k$ for SSR1 in India
    - 250 k$ Meson Beamline Services
  - Could live with 3.6 M$
- Guideline
  - 0.73 M$ for M&S

First Priorities	**Test Cryo**	Test Cryostat FINAL	150	20
		Test Cryostat Installation & Accessories	25	
	RFQ	Acceptance Test (RF Power)	20	
		Acceptance Test (Beam Performances)	50	
	SC Spoke Cavit	2 SSR1 Cavities India	50	
		4 SSR1 He Vessels	60	20
		4 SSR1 Slow Tuners	40	
		4 SSR1 Fast Tuners	40	
		6 Power Couplers (plus Ceramics)	162	
		SC SSR1 Tooling	25	
	MOU Contracts	ANL-Shepard (SSR1 India Processing)	175	
		ANL-Ostroumov	250	
		LBNL (Buncher Cavities Construction)	100	
	Solenoids	SC Wire (23)	50	
		RT Solenoids (23)	140	
		RT Cryostats (23)	540	
		RT Power Leads (46)	70	
	RT Cavities	RT Cavities #2-#10	550	
		RT Power Couplers (16)	70	
		RT Tuners (32)	72	
		RT Cavities Services (Pumps, Water, et	100	
		RT Cavities Tooling	20	
		Rail	50	
		Tooling for Testing	10	
	RF	RFQ-RT 10Hz	60	
		4-quadrant Power Supply	40	
		325 MHz Klystron Commissioning	20	
		Power Distribution System	80	
	Guest Personnel	G. Galasso - Eng.	45	
		Vladislav Aseev - ANL Beam Simulation	90	
	Ion Source	Preparation H+	50	
		Preparation H-	100	
	PD Travel	Overall Travel	50	
	Services & LLR	Controls	100	
		Cooling Water	25	
		Cryo Installation	60	
		Beam Diagnostic	60	
Total First Priorities			***3590***	***40***
Second Priorities	**Chopper/MEBT**	Chopper	100	
	SC Spoke Cavit	SSR1 Full Order (India - 22 Cavities)	550	
		SSR1 Vessels Full Order (22 Vessels)	330	110
		SSR1 PC Full Order	220	
	RF	Spare Klystron	510	
Total Second Priorities			***1710***	
Grand Total			***5300***	

Funding in FY07 - Reality

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- Plans
  - Test Cryostat 150 k$
  - 2 SSR1 + 2 India (completion) 125 k$
  - All RT Sol+10 Cav. (or viceversa) 1363 k$
  - ANL-BNL MOUs 300 k$
  - RF 200 k$
  - Services (cryo, water) 230 k$
- **Total 2.7 M$**

Actual Budget FY07: 2.2 M$
+0.25 M$

		M&S (k$
Test Cryo	Test Cryostat FNAL	150
	Test Cryostat Installation & Accessories	25
RFQ	Acceptance Test (RF Power)	20
	Acceptance Test (Beam Performancer)	50
SC Spoke Cavities	2 SSR1 He Vessels	30
	2 SSR1 Slow Tuners	20
	2 SSR1 Fast Tuners	20
	2 Power Couplers (plus Ceramics)	54
MOU Contracts	ANL-Shepard (SSR1 India Processing)	50
	ANL-Ostroumov	150
	LBNL (Buncher Cavities Construction)	100
	India MOU	50
Solenoids	SC Wire (23)	50
	RT Solenoids (23)	140
	RT Cryostats (23)	540
	RT Power Leads (46)	70
RT Cavities	RT Cavities #5-#10	400
	RT Power Couplers (#2-#10)	61
	RT Tuners (16)	72
	RT Cavities Services (Pumps, Water, etc.)	20
	RT Cavities Tooling	10
	Rail & Misc.	50
RF	RFQ-RT IQMs	60
	4-quadrant Power Supply	40
	325 MHz Klystron Commissioning	20
	Power Distribution System	80
Guest Personell	Slava Asseev - ANL Beam Simulation	45
Ion Source	Preparation H+	20
	Preparation H-	20
PD Travel	Overall Travel	15
Services & LLRF	Controls	50
	Meson Fire System	23
	Cooling Water	25
	Cryo Installation	100
	Beam Diagnostic	30
		2666

Plans for FY08

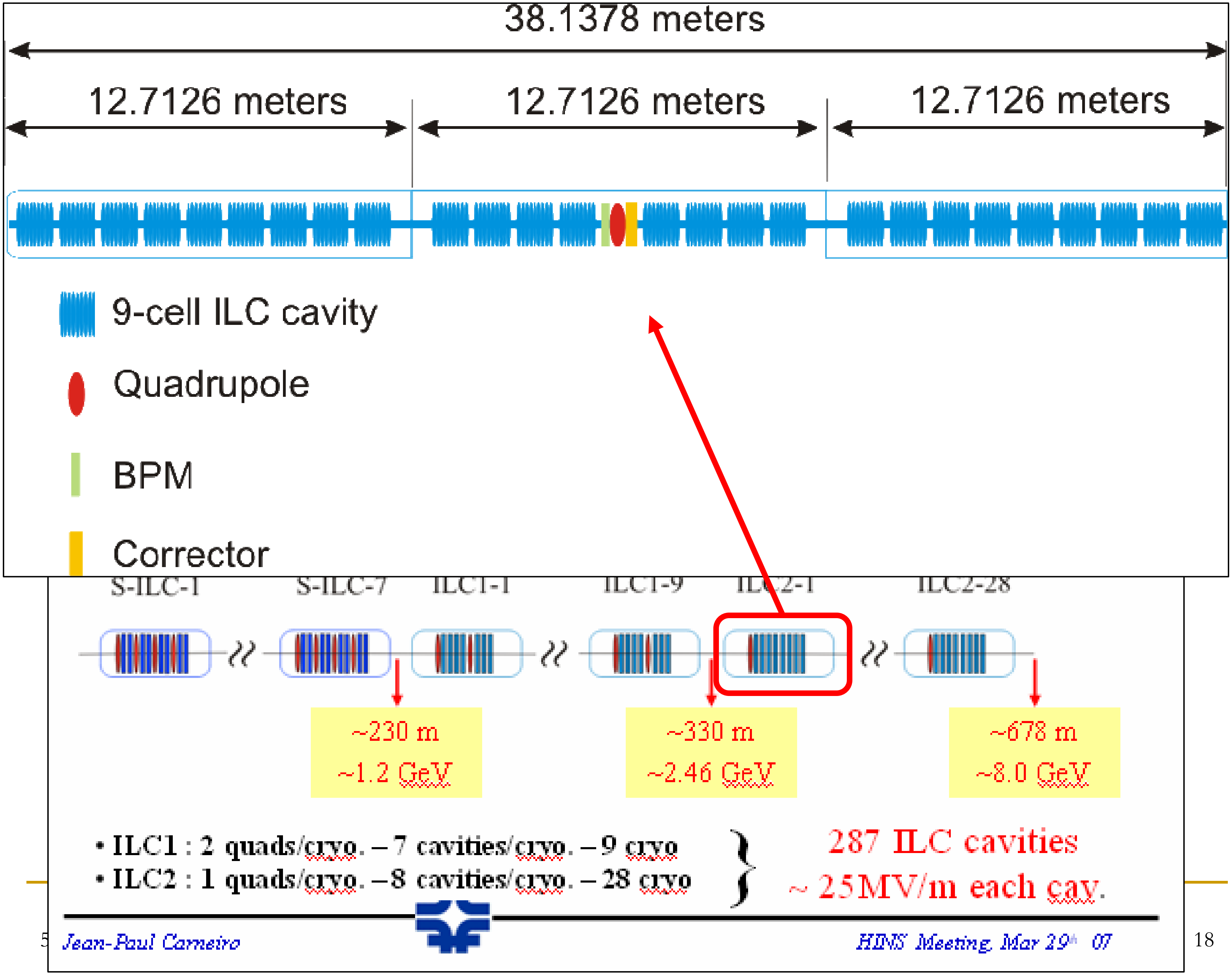
- Goal: stay on track for FE delivery in 2010
  - Complete & Operate RT
  - Procure & Test all SSR1 (18)
    - No cryomodule or focusing solenoids
- Plans
  - Cryo in Meson 200 k$
  - Spare Klystron 600 k$
  - RF Distribution 400 k$
  - Utilities 600 k$
  - Last RT Cavities 450 k$
  - SSR1 (India) 2000 k$
  - MOUs (ANL, LBL) 330 k$
- **Total** **5.1 M$**

			M&S (k$)
30.13.1 (Project Mana	**Travel**	Overall Travel	50
30.13.2 (Civil Design)	**FESS/Consultants**		
30.13.3 (Accelerator Systems)			
	Beam Diagn & Instr.	BPMs, CTs, Profile Mon + Elect.	50
	Modulators, etc		-
	Cryogenics	Cryo Distribution to Tunnel (up to RT)	200
	Klystron	Spare Klystron 325 MHz	600
	RF	Distribution to RT Section	150
		SSR1 IQMs	250
	Utilities	RT Solenoid & IQM Power Supplies	400
		Water/Water Distribution system	200
		Installation incl. electricians/pipefitters/et	70
	Acc. Control & Softw.	Crates, Cars, etc for general control	125
30.13.4 (Beam Line Components)	**System Engineering**		
	IS through MEBT	Operation H+	10
		Operation H-	70
	RT Section	RT Cavities #11-16	400
		RT Power Couplers #11-16	50
	Spoke Cryomodules	Niobium	750
		18 (Production) SSR1 (India@20k$)	360
		18 SSR1 He Vessels	270
		18 SSR1 Fast Tuners	180
		18 SSR1 Power Couplers	450
	Guest Personell	Slava Aseev - ANL Simulation	90
	MOU Contracts	ANL - Ostroumov	150
		ANL - Etching	150
		LBNL - Buncher Testing	30
			5055

HINS/6 GeV ILC Alignment

HINS

- Idea:
  - Develop and build several ILC RF-units (5 or 6) for system integration studies, *….ILC justifications….*
  - If ILC (delayed beyond 20##, not technically feasible, not right energy, etc.) then use facility as last accelerating stage of high intensity proton machine
- Items presently being considered (in order of "seriousness" of effort applied):
  - Beam dynamics — Ostroumov, Carniero actively simulating
  - Power input to cavities — Khabibouline providing "expertise"
  - Civil Engineering — …need FESS involvement, maybe at at Directorate level ? …


38.1378 meters
12.7126 meters
12.7126 meters
12.7126 meters
9-cell ILC cavity
Quadrupole
BPM
Corrector
S-ILC-1
S-ILC-7
ILC1-1
ILC1-9
ILC2-1
ILC2-28
~230 m
~1.2 GeV
~330 m
~2.46 GeV
~678 m
~8.0 GeV
• ILC1 : 2 quads/cryo. – 7 cavities/cryo. – 9 cryo
• ILC2 : 1 quads/cryo. – 8 cavities/cryo. – 28 cryo
287 ILC cavities
~ 25MV/m each cav.
Jean-Paul Carneiro
HINS Meeting, Mar 29th 07

Beam Dynamics

HINS

8 ILC Unit after ILC1 (to replace ILC2)

- **ILC2 : 1 quads/cryo. – 8 cavities/cryo. – 28 cryo – 224 cavities – 28 quads**
- **8 ILC-units : (9+8+9)×8 = 208 cavities – 8 quads**

idea

ILC1 – 31.5 MV/m

4 ILC Units – 18.25 MV/m

4 ILC Units – 31.5 MV/m

~330 m
~~~2.46 GeV~~
~2.8 GeV

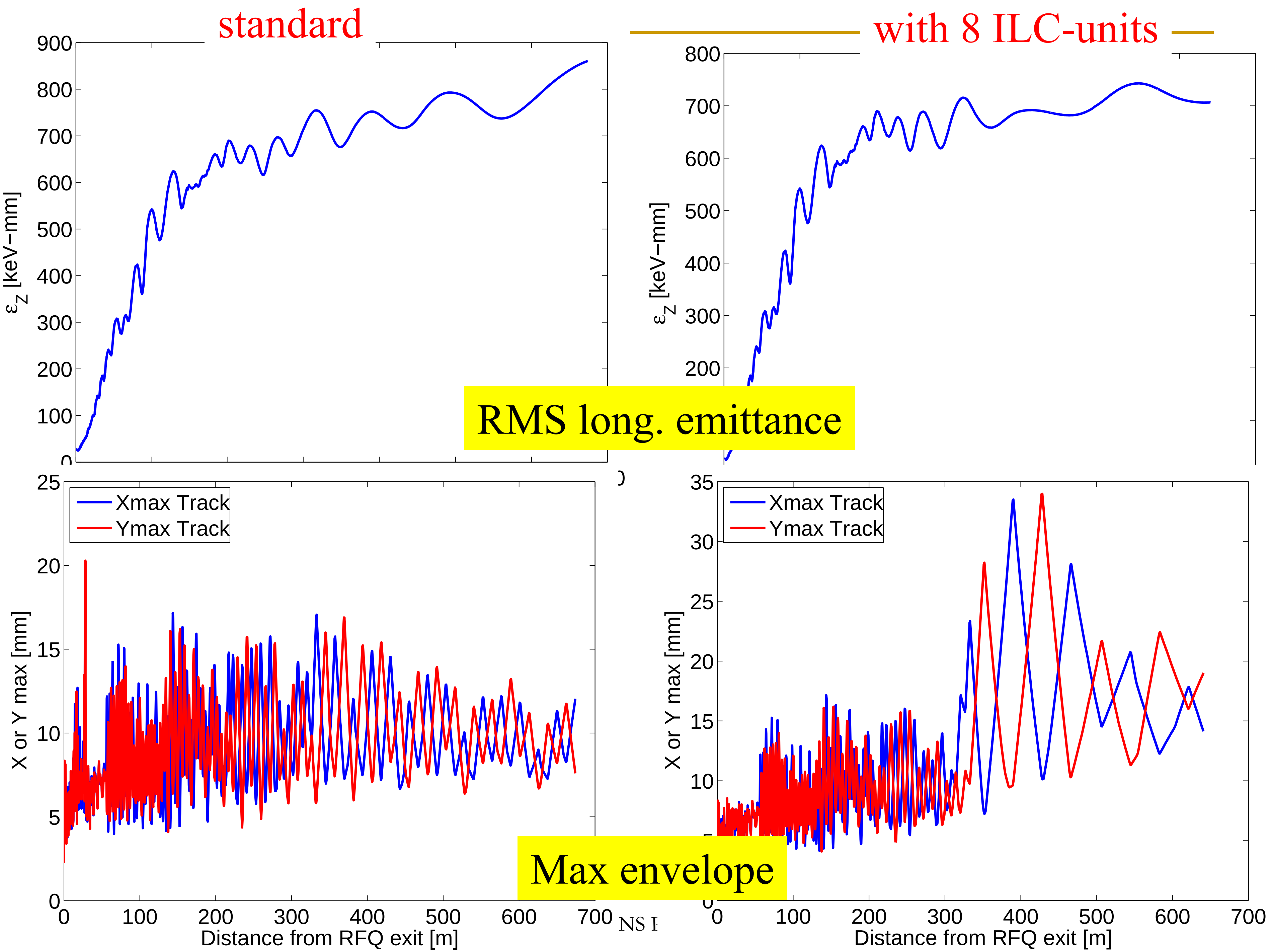
Lower fields helps RF defoc.

~~~678 m~~
~640 m
~8.0 GeV

Higher energy helps Space Charge

Jean-Paul Carneiro

HINS Meeting Mar 29th 07


standard
with 8 ILC-units
RMS long. emittance
Max envelope
ε_Z [keV−mm]
X or Y max [mm]
Xmax Track
Ymax Track
Distance from RFQ exit [m]
NS I

Power to Cavities

HINS

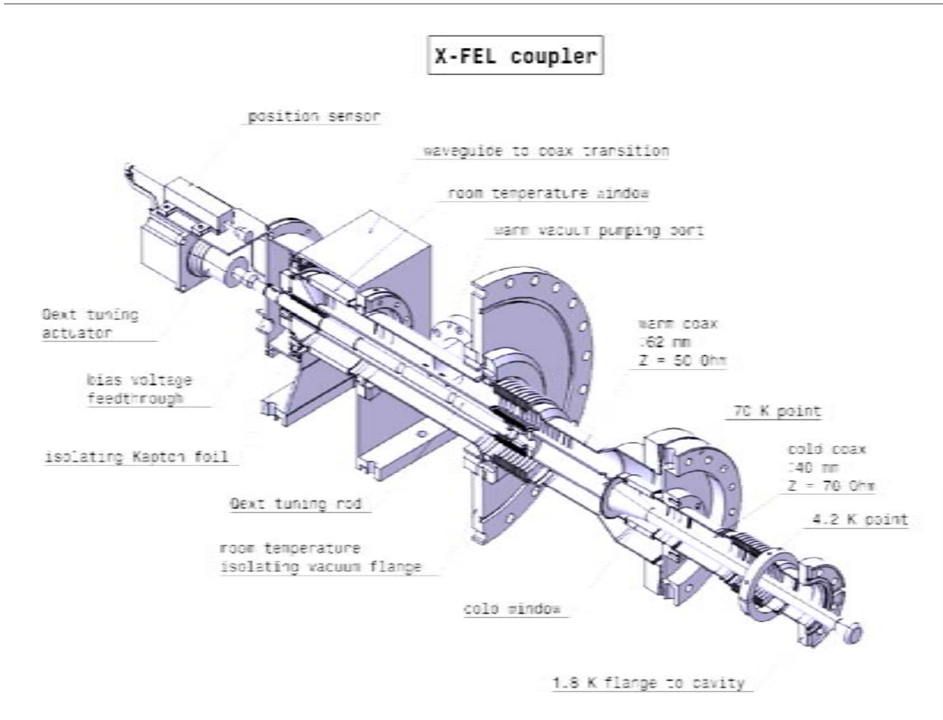
	ILC	HINS/ILC	HINS
I, mA	9	26	26
Eacc, MV/m	31.5	31.5	26
U, MV	32.7	31.4	25.9
Tbeam	969	1000	1000
Tfill	596	215	223
Rep. rate	5	10	10
Phase, deg	1	16	16
P pulse, kW	294	817	674
P average, kW	2.30	9.92	8.25
Qext, coupler	3.7E+06	1.3E+06	1.1E+06

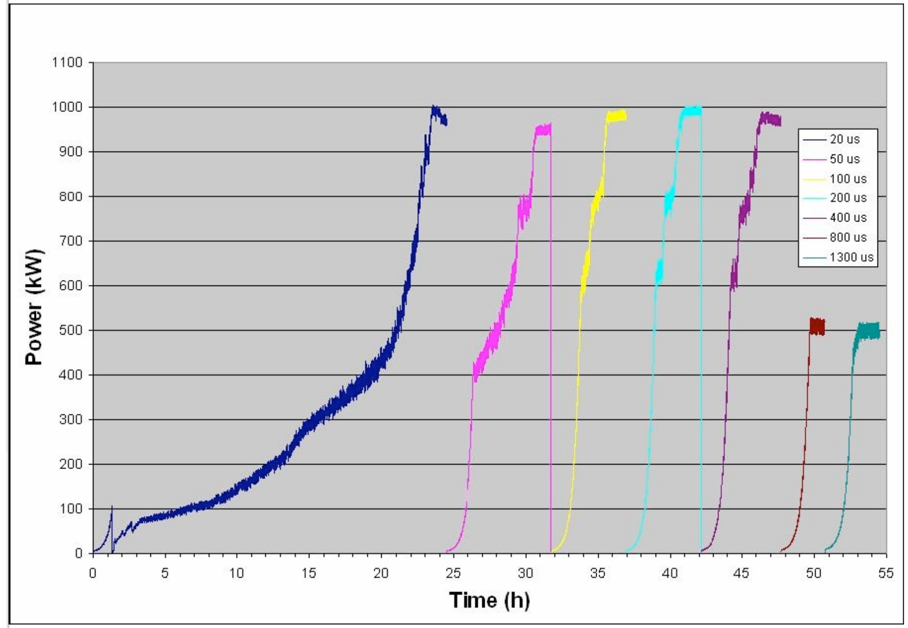
The TTF3 coupler goes only up to average power of 4.5kW traveling wave. The limiting effect is the temperature of the warm inner conductor. Bessy did some tests with air cooling of the inner conductor and were able to go to 10kW average at a cavity.

Sergey Belomestnykh
sab@lepp.cornell.edu
has a TTF3 like design with cooling of the inner conductor and increased cold coax diameter. It is under test right now and should go up to 80kW cw.

Tesla Power Coupler

HINS





- ILC Power Coupler as presently conceived will not work, but:
  - Lot of work on improving performance
  - Adjustable coupling to become available in TTFIII
  - If not adjustable, design needs to be optimized for 26 mA
- ..or, PC replacement (see next)

INPUT COUPLER FOR ERL INJECTOR CAVITIES *

V. Veshcherevich., I. Bazarov, S. Belomestnykh, M. Liepe, H. Padamsee, and V. Shemelin. Laboratory for Elementary-Particle Physics, Cornell University, Ithaca, NY 14853, USA

Table 1: Parameters of the injector cavities
Energy of electrons, *E* 0.5 to 5.5 (15.5) MeV
Beam current, *I*0 100 (33) mA
Frequency, *f* 1300 MHz
Number of cells per cavity, *N*c 2
*Q*0 ≥ 5×109
*Q*ext, nominal 4.6×104
*Q*ext, range 4.6×104 to 4.1×105
R/Q 218 Ohm
Cavity voltage, *V* 1 (3) MV
RF power per cavity, *P* 150 kW

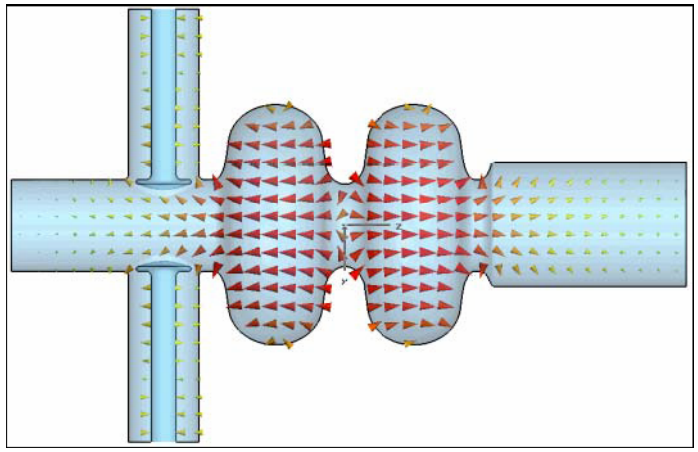
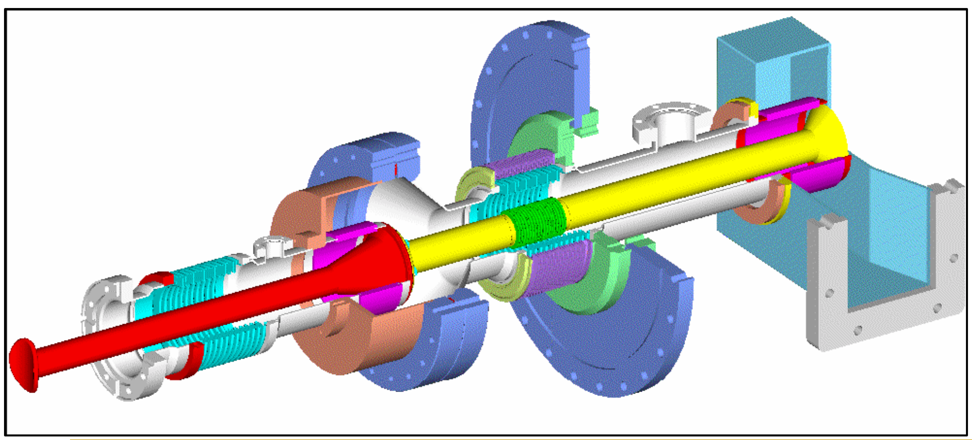
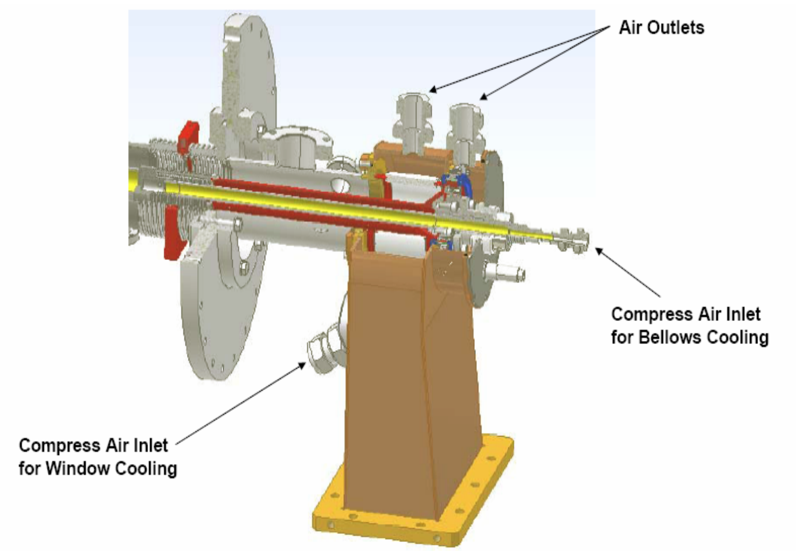


Table 2: Injector cavity coupler heat loads.

	Static	At 50 kW (CW, TW)
1.8 K	0.05W	0.2W
4.2 K	0.30W	2.0W
70 K	6.80W	31W

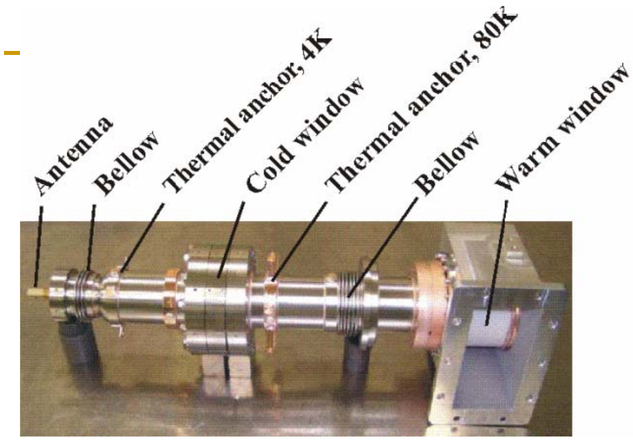
Cornell ERL – Modified TTFIII for CW mode

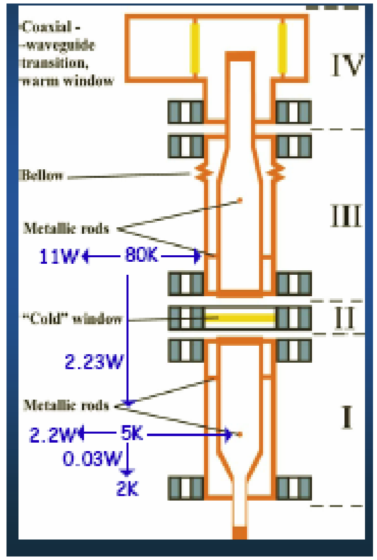


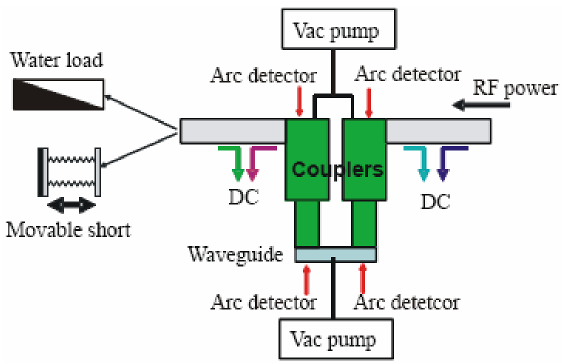


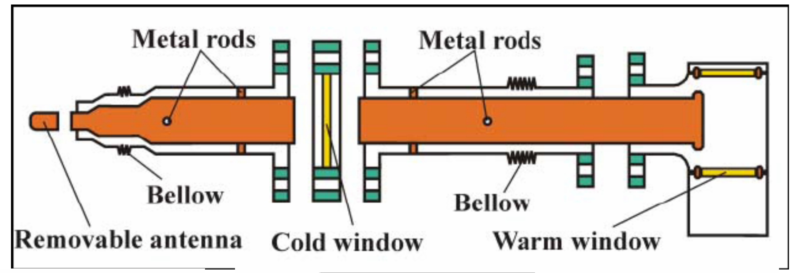
HIGH POWER TEST OF COUPLER WITH CAPACITIVE WINDOW. S. Kazakov1, H. Matsumoto1, K.Saito1, T.Higo1, T.Saeki1, M.Sato1, F.Furuta1, R.Orr2, J.Hong1, A.Yano3, H.Urakata3, O.Yushiro3

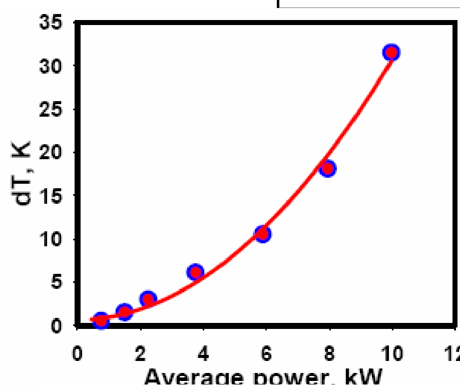
KEK – Capacitive coupling
1 cylindrical – 1 planar

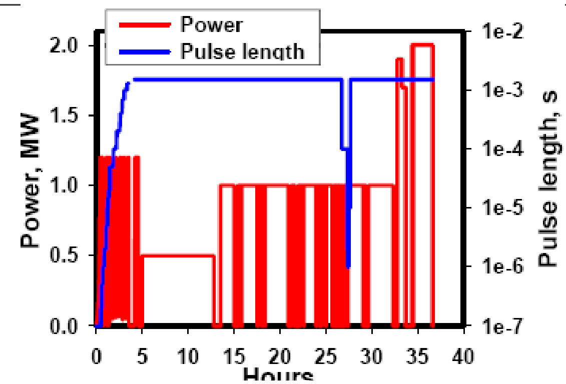


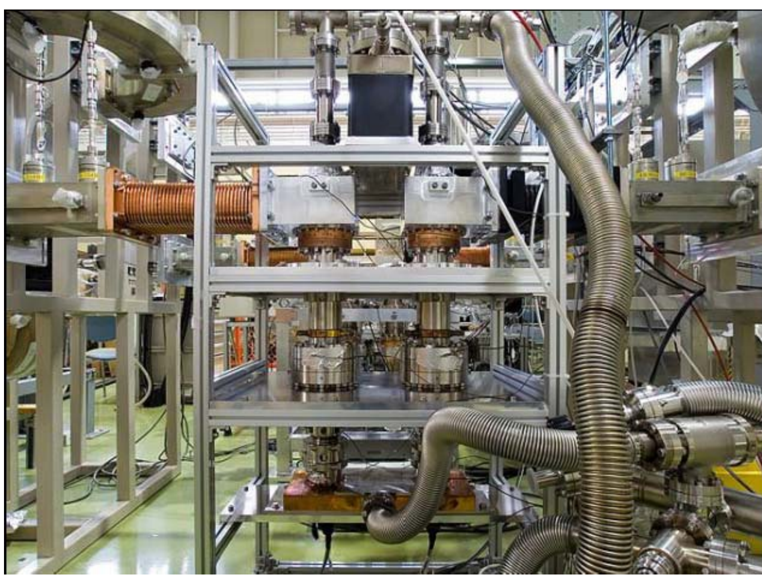










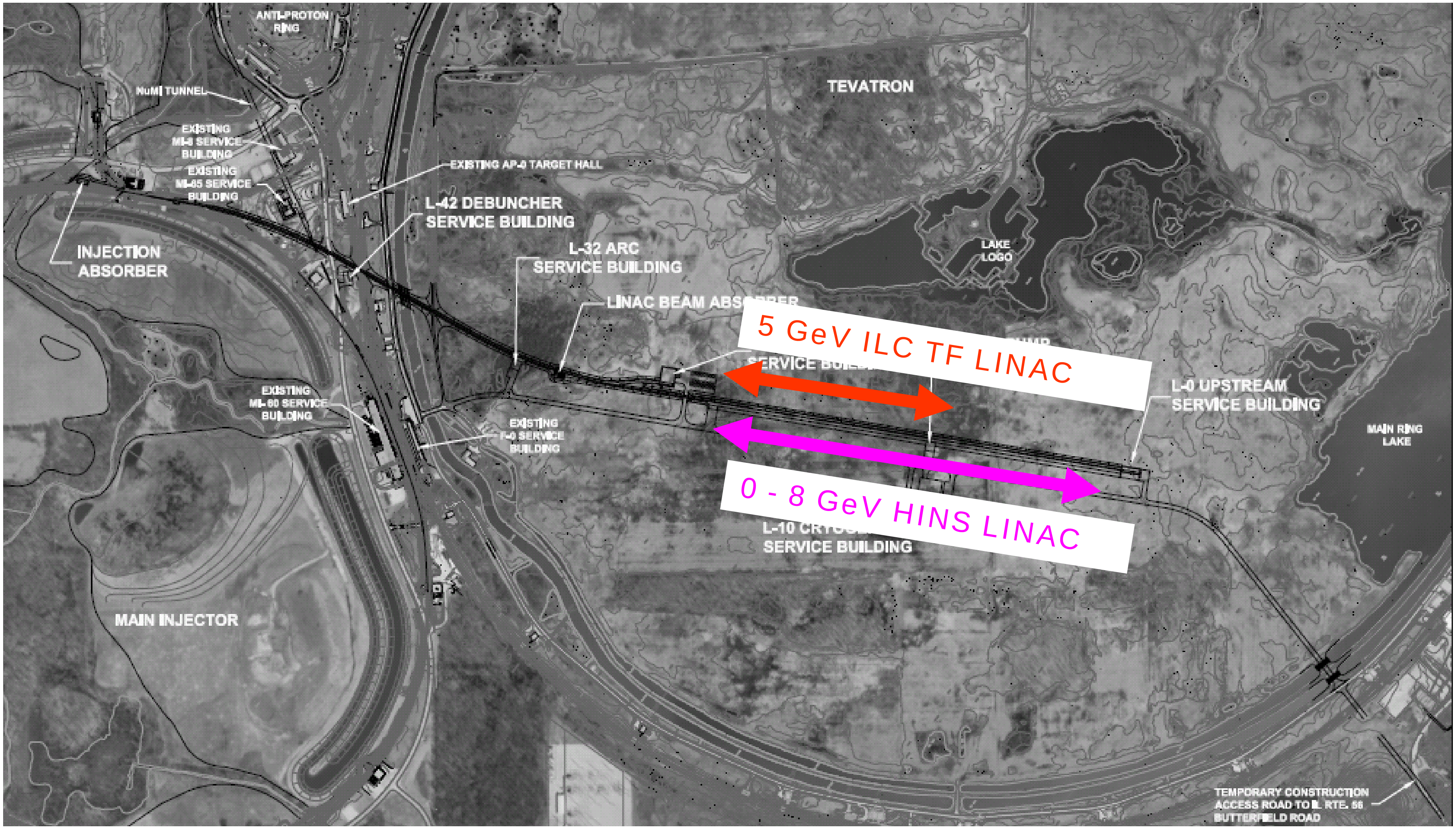


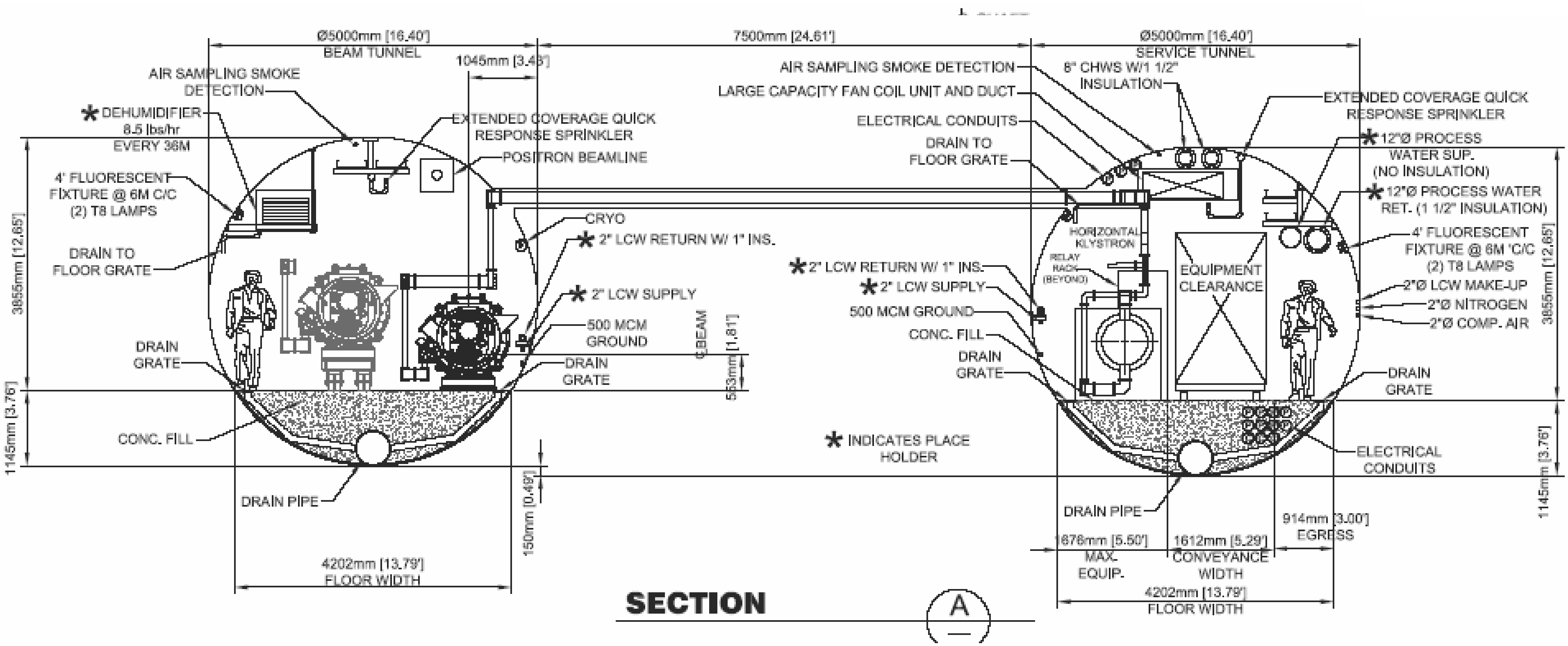
CONCLUSION

The L-band high-power couplers with capacitive coupling mechanism at the cold window were made for superconductive accelerator cavity. Couplers were tested at high power level. Test demonstrated that couplers can successfully operate with pulse 1MW x 1.5ms x 5pps and 2MW x 1.5ms x 3pps with matching load and with pulse 500kW x 1.5ms x 5pps with short. Effect of multipactor is weak. Upper limit of multipactor is about 200 kW. These couplers will be used for STF in KEK.

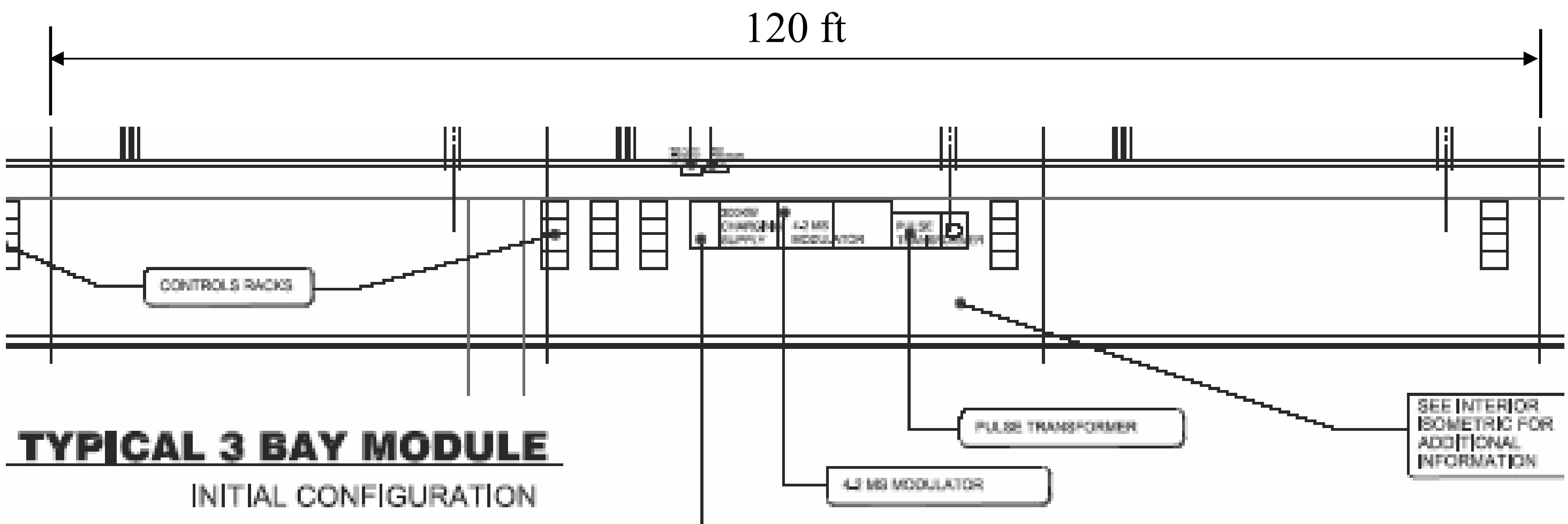
Linac Proton Driver Site Plan

HINS

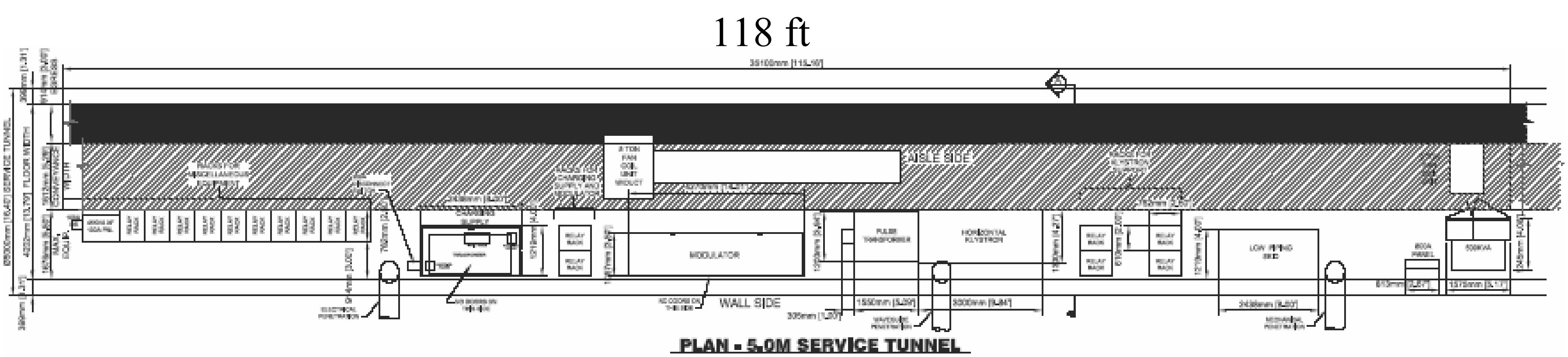



Ø5000mm [16.40'] BEAM TUNNEL
7500mm [24.61']
Ø5000mm [16.40'] SERVICE TUNNEL
1045mm [3.43']
AIR SAMPLING SMOKE DETECTION
* DEHUMIDIFIER 8.5 lbs/hr EVERY 36M
4' FLUORESCENT FIXTURE @ 6M C/C (2) T8 LAMPS
DRAIN TO FLOOR GRATE
DRAIN GRATE
CONC. FILL
DRAIN PIPE
4202mm [13.79'] FLOOR WIDTH
150mm [0.49']
EXTENDED COVERAGE QUICK RESPONSE SPRINKLER
POSITRON BEAMLINE
CRYO
* 2" LCW RETURN W/ 1" INS.
* 2" LCW SUPPLY
500 MCM GROUND
DRAIN GRATE
CBEAM
553mm [1.81']
AIR SAMPLING SMOKE DETECTION
LARGE CAPACITY FAN COIL UNIT AND DUCT
ELECTRICAL CONDUITS
DRAIN TO FLOOR GRATE
8" CHWS W/1 1/2" INSULATION
HORIZONTAL KLYSTRON
RELAY RACK (BEYOND)
* 2" LCW RETURN W/ 1" INS.
* 2" LCW SUPPLY
500 MCM GROUND
CONC. FILL
DRAIN GRATE
EQUIPMENT CLEARANCE
EXTENDED COVERAGE QUICK RESPONSE SPRINKLER
* 12"Ø PROCESS WATER SUP. (NO INSULATION)
* 12"Ø PROCESS WATER RET. (1 1/2" INSULATION)
4' FLUORESCENT FIXTURE @ 6M 'C/C (2) T8 LAMPS
2"Ø LCW MAKE-UP
2"Ø NITROGEN
2"Ø COMP. AIR
DRAIN GRATE
ELECTRICAL CONDUITS
3855mm [12.65']
1145mm [3.76']
* INDICATES PLACE HOLDER
DRAIN PIPE
1676mm [5.50'] MAX. EQUIP.
1612mm [5.29'] CONVEYANCE WIDTH
914mm [3.00'] EGRESS
4202mm [13.79'] FLOOR WIDTH
SECTION
A

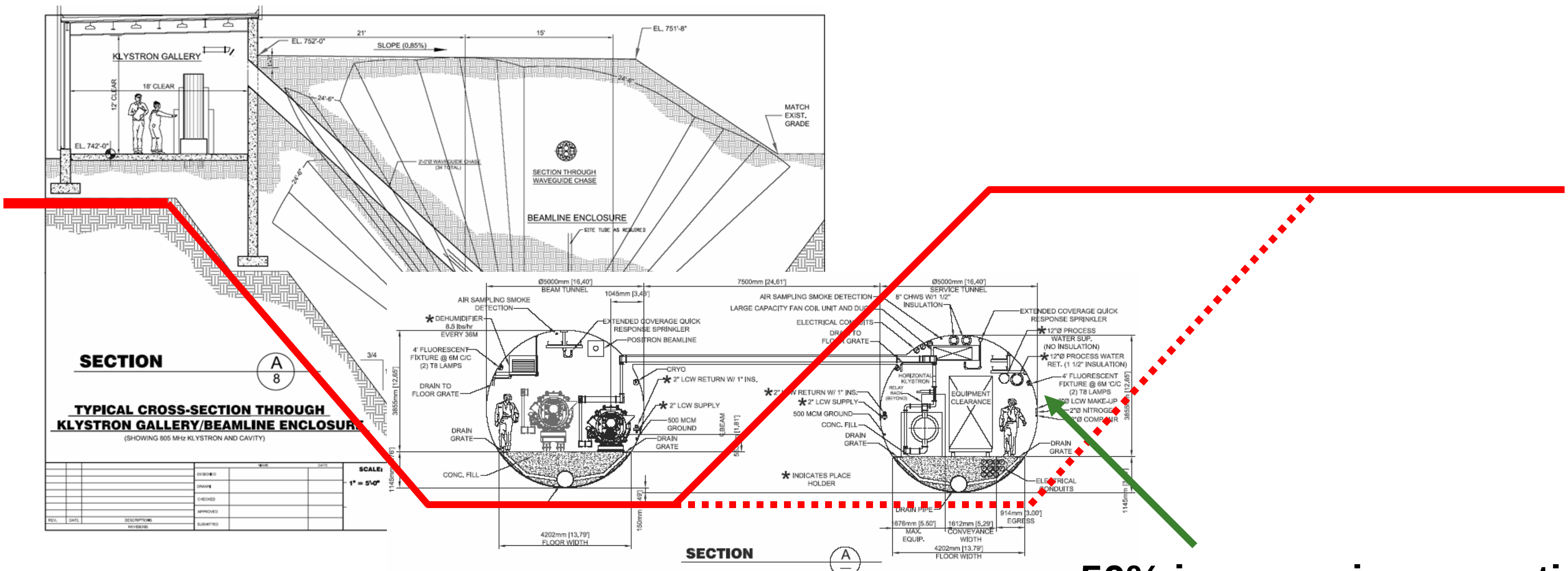
Klystron Gallery (HINS)/Tunnel (ILC)



HINS GALLERY



ILC SERVICE TUNNEL



- **~50% increase in excavation**
- **Excavation is ~15% of civil**